

Contents

1	Probing Electron Dynamics in Simple Molecules with Attosecond Pulses	1
	Paula Rivière, Alicia Palacios, Jhon Fredy Pérez-Torres, and Fernando Martín	
1.1	Introduction	1
1.2	Probing Electron Dynamics with Ultrashort Pulses	3
1.2.1	Intense IR Fields	4
1.2.2	XUV Fields	4
1.2.3	SAP + IR	5
1.2.4	APT+IR	6
1.3	Theoretical Method	8
1.3.1	Time-Dependent Schrödinger Equation	8
1.3.2	Molecular Electronic and Nuclear States	9
1.3.3	Time-Dependent Close-Coupling Method	10
1.3.4	Asymmetric Electron Ejection	11
1.4	H ₂ and D ₂ Dissociative Ionization by Two-Color (XUV+IR) Fields	17
1.4.1	Single Attosecond Pulse plus Infrared: Electron Localization	17
1.4.2	Attosecond Pulse Train plus Infrared: Role of Different States	20
1.5	Conclusions and Outlook	25
	References	26
2	Enhanced Ionization of Molecules in Intense Laser Fields	29
	Andre D Bandrauk and François Légaré	
2.1	Introduction	29
2.2	Quasistatic Models: Diatomic One-Electron Systems in Strong Fields	31

2.3	Double Ionization in Strong Fields	38
2.4	Coulomb Explosion Imaging of CREI in Triatomics	41
	References	44
3	Ultrafast Optical Gating by Molecular Alignment	47
	Heping Zeng, Peifen Lu, Jia Liu, and Wenxue Li	
3.1	Introduction	48
3.2	Principle of Ultrafast Molecular Gating	49
	3.2.1 Molecular Alignment Based Ultrafast Birefringence	49
	3.2.2 Dynamics of Molecular Rotational Wave-Packets	49
	3.2.3 The Molecular Alignment Matrices	51
	3.2.4 Weak Field Polarization Spectroscopic Technique	52
	3.2.5 Alignment-Induced Polarization Optical Gating	53
3.3	Molecular-Alignment-Based Cross-Correlation Frequency-Resolved Optical Gating	55
	3.3.1 Frequency-Resolved Optical Gating	55
	3.3.2 XFROG by Molecular Alignment Optical Gating	59
	3.3.3 Experimental Results by M-XFROG	62
	3.3.4 Discussions on M-XFROG Applicability	64
3.4	Ultrafast Optical Imaging by Molecular Alignment	67
3.5	Conclusions	74
	References	75
4	Experiments in Population Trapping in Atoms and Molecules by an Intense Short Laser Pulse	79
	S.L. Chin, A. Azarm, H.L. Xu, T.J. Wang, M. Sharifi, and A. Talebpour	
4.1	Introduction	80
4.2	Qualitative Physics of Population Trapping	80
4.3	Previous Experimental Observation	82
4.4	Physical Picture of Molecular Trapping	84
4.5	More Recent Work in Trapping	85
4.6	Probing Population Trapping in Nitrogen Using 400 nm Pulses	86
4.7	Probing Trapping in Nitrogen Using 1,338 nm Pulses	90
4.8	Probing Trapping in Nitrogen and Other Gases Using THz Pulses	91
4.9	Trapping: A Universal Phenomenon for All Atoms and Molecules Including Biomolecules	92
4.10	Excitation of Super-Excited States Through Trapping by a Strong Laser Field	93
4.11	Conclusion	94
	References	95

5 Two-XUV-Photon Processes: A Key Instrument in Attosecond Pulse Metrology and Time Domain Applications.....	97
P. Tzallas, J. Kruse, E. Skantzakis, L.A.A. Nikolopoulos, G.D. Tsakiris, and D. Charalambidis	
5.1 Introduction	98
5.2 Sources of Energetic Attosecond Pulses.....	100
5.2.1 Pulse Energy Restricting Factors and Possible Solutions ...	100
5.2.2 Intense Broadband Coherent XUV Continua	101
5.2.3 On the CEP of Energetic 1fs to Sub-fs Scale Pulses.....	101
5.3 Two-XUV-Photon Processes and Pulse Metrology	103
5.3.1 Pulse Metrology Techniques	104
5.3.2 Comparative Studies Between the Second Order IVAC and RABITT.....	106
5.4 XUV-Pump-XUV-Probe Experiments at the 1-fs Scale	112
5.4.1 The Two-XUV-Photon Double Ionization of Xenon Scheme.....	112
5.4.2 The Second Order IVAC of the Continuum Radiation	114
5.4.3 XUV-Pump-XUV-Probe of an Atomic Coherence	115
5.5 Conclusions and Outlook.....	117
References	118
6 Controlling the Motion of Electronic Wavepackets Using Cycle-Sculpted Two-Color Laser Fields	121
M. Kitzler, X. Xie, S. Roither, D. Kartashov, and A. Baltuška	
6.1 Introduction	121
6.2 Experiment	123
6.3 Measured Electron Momentum Spectra and Influence of the Coulomb Field	126
6.3.1 Field-Driven Wavepacket Motion	126
6.3.2 Influence of the Coulomb Field on the Spectral Mean Value	128
6.3.3 Influence of the Coulomb Field on the Spectral Width	129
6.3.4 Wavepacket Motion in the Lateral Direction.....	132
6.4 Laser Subcycle Interference Structures	135
6.4.1 Controlling Subcycle Interference Structures	135
6.4.2 Retrieval of Wavepacket Dynamics from Interference Structures	138
6.5 Conclusion	140
References	141
7 Characterization of Femtosecond Laser Filament-Induced Plasma and Its Application to Atmospheric Sensing.....	145
HuaiLiang Xu, Ya Cheng, ZhiZhan Xu, and See Leang Chin	
7.1 Introduction	145
7.2 Optical Emission Spectroscopy for Characterizing Filamentation-Induced Plasma	147

7.3	Physical Properties of Filamentation Induced Plasma of Solid Targets	148
7.4	Physical Properties of the Plasma Filament in Air	152
7.5	Lasing Actions Occurring in the Plasma Filament in Air	154
7.6	Application to Atmospheric Sensing	156
7.7	Summary	158
	References	159
8	Cascaded Laser Wakefield Acceleration Scheme for Monoenergetic High-Energy Electron Beam Generation	161
	Jiansheng Liu, Wentao Wang, Haiyang Lu, Changquan Xia, Mingwei Liu, Wang Cheng, Aihua Deng, Wentao Li, Hui Zhang, Jiancai Xu, Xiaoyan Liang, Yuxin Leng, Xiaoming Lu, Cheng Wang, Jianzhou Wang, Baifei Shen, Kazuhisa Nakajima, Ruxin Li, and Zhizhan Xu	
8.1	Introduction	162
8.2	A Cascaded Laser Wakefield Accelerator Using Ionization-Induced Injection	163
8.2.1	Experimental Setup	163
8.2.2	Quasi-Monoenergetic e-Beam Generation from the Cascaded LWFA	164
8.2.3	GeV-Class Quasi-Monoenergetic e-Beam Generation from the Cascaded LWFA with 3-mm-Thick Second Gas Cell	167
8.3	Cascaded Laser Wakefield Acceleration of Electron Beams Beyond 1 GeV from an Ablative Capillary Discharge Waveguide	169
8.3.1	Experimental Setup	169
8.3.2	Optical Guiding for the Laser from an Ablative Capillary Discharge Waveguide	170
8.3.3	Cascaded Laser Wakefield Acceleration of Electron Beams Beyond 1 GeV from an Ablative Capillary Discharge Waveguide	171
8.4	Summary	174
	References	174
9	Laser Radiation Pressure Accelerator for Quasi-Monoenergetic Proton Generation and Its Medical Implications	177
	C. S. Liu, X. Shao, T. C. Liu, J. J. Su, M. Q. He, B. Eliasson, V. K. Tripathi, G. Dudnikova, R. Z. Sagdeev, S. Wilks, C. D. Chen, and Z. M. Sheng	
9.1	Introduction	178
9.1.1	Brief Introduction on Particle Therapy for Cancer Treatment	179
9.1.2	Schemes for Laser Proton Acceleration	179

9.2	Quasi-Monoenergetic Proton Generation with RPA	180
9.2.1	Criteria for RPA	180
9.2.2	Underlying Theory of the RPA in One-Dimension	181
9.2.3	Rayleigh–Taylor Instability-Induced Transparency and Particle Energy Spectrum Broadening ...	184
9.2.4	Energy Scaling of RPA Generation of Quasi-Monoenergetic Protons	184
9.2.5	Promising Experimental Evidence of the RPA of an Ultra-Thin Carbon Target	186
9.3	Other Forms of RPA	187
9.3.1	Multi-Ion Target Acceleration with RPA	187
9.3.2	RPA of Gas Target	187
9.4	Medical Implications of Quasi-Monoenergetic Proton Beam Generated from RPA: Laser-Proton Cancer Therapy with the RPA-Based Laser Proton Accelerator	190
9.5	Summary	193
	References	194
	Index	197

Progress in Ultrafast Intense Laser Science VIII

Yamanouchi, K.; Nisoli, M.; Hill, III, W.T. (Eds.)

2012, XII, 204 p., Hardcover

ISBN: 978-3-642-28725-1